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 [21] Appl. No. **760,238**
 [22] Filed **Sept. 17, 1968**
 [45] Patented **Feb. 23, 1971**
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3,273,242 9/1966 Andrew 32/12
 3,457,644 7/1969 Susman 32/2
 3,462,838 8/1969 Alster Gren 32/12

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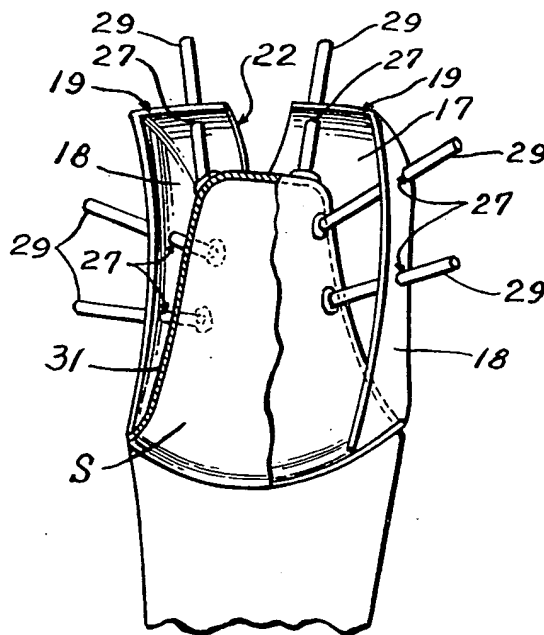
[54] **PREFABRICATED DENTAL PATTERN HAVING
 ADJUSTING SLOT MEANS**
 6 Claims, 8 Drawing Figs.

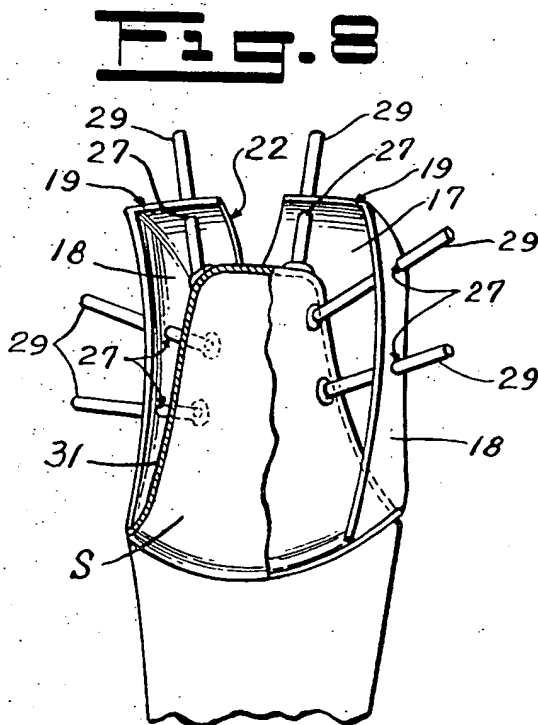
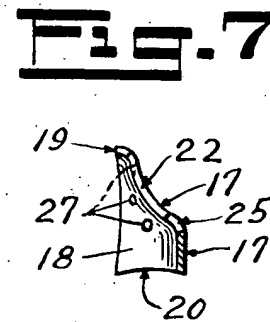
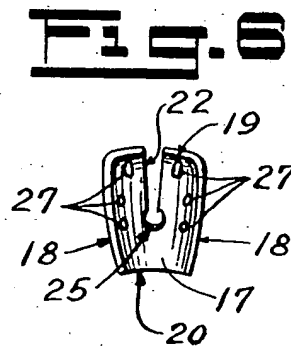
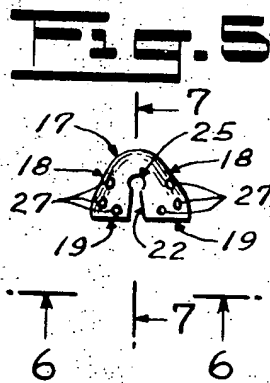
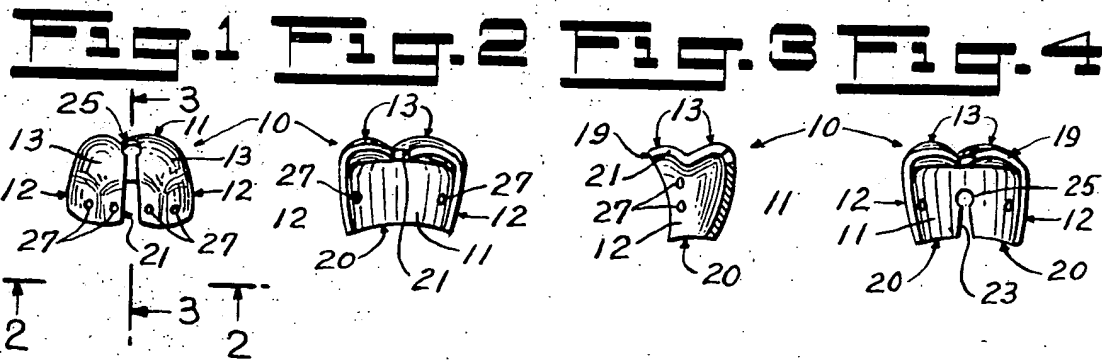
[52] U.S. Cl. 249/54;
 18/33; 18/34.1; 32/2; 32/12; 32/17; 264/16;
 264/19
 [51] Int. Cl. A61c 9/00,
 A61c 13/00
 [50] Field of Search 299/54, 55;
 32/2, 12, 17; 264/16, 19; 18/33, 34.1

[56] **References Cited**
UNITED STATES PATENTS

3,120,704 2/1964 Newcomb 32/12
 3,224,050 12/1965 Redtenbacher 249/54X

ABSTRACT: A thin pattern for a lingual frame or portion of a dental restoration is disclosed and has particular applicability to the type known as a veneer crown or veneer-type bridge. The pattern includes the lingual wall and the mesial and distal walls extending forwardly therefrom. The outer surfaces of these walls conform, or conform approximately to the surfaces of the corresponding or particular natural tooth. The pattern has slot means, preferably a single central slot, extending rearwardly from the incisal or forward edge to roughly a mid point of the pattern so that the pattern can be narrowed or widened to conform to the space between abutting teeth. The gingival portion of the pattern is rounded so as to fit or can be modified to fit on a coping or a tooth stub. The pattern is made of plastic material or a suitable metal such as gold, having sufficient softness or pliability so that it can be modified to suit the dental technician as to shape, and/or dimension and having sufficient retentivity so that the pattern remains fixed in the adjusted or modified form.





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PREFABRICATED DENTAL PATTERN HAVING ADJUSTING SLOT MEANS

In making a restoration either a single tooth or a bridge, the present practice is to carve or shape in wax, the lingual portion of the tooth or teeth to be replaced, whereupon the wax pattern or form is or forms are invested in a mold. The wax is burned out from the mold cavity by applying heat in known manner. The mold cavity is then filled with dental metal, in known manner, to form a cast frame. The carving of the wax form requires considerable time and requires a highly skilled dental technician. With the pattern herein, the dental technician selects the proper pattern or patterns for the tooth or teeth to be replaced and widens or narrows the pattern or patterns, if necessary, to fit into the space between the two abutting teeth, after which the slot and interior of the pattern is filled with wax and perhaps the bottom portion is filled or extended with wax to complete the exterior and interior form of the frame construction as well as its length, if needed, for the tooth or teeth of the bridge. A pattern will be provided for at least each different tooth so that the proper pattern or patterns may be selected by the technician depending upon the restoration to be made.

It is an object of the invention to provide a prefabricated thin pattern of the lingual portion of each different tooth with each pattern having a lingual surface, a mesial surface and distal surface corresponding with its respective tooth with each molar pattern also having an occlusal surface corresponding with its respective tooth which patterns can be easily and quickly modified by a technician of moderate skill and the resultant modified pattern remains in its modified form.

Another object of the invention is as in the preceding paragraph and to provide the prefabricated pattern in plastic or gold.

Another object is to provide a method or technique which uses the pattern or patterns for more quickly and inexpensively producing a dental restoration which also does not require a highly skilled technician.

Other objects of the invention will be more apparent from the following description when taken in connection with the accompanying drawings illustrating a preferred form of the invention in which:

FIG. 1 is a top view of a pattern for a molar;

FIG. 2 is a front view of the pattern as viewed from line 2-2 of FIG. 1;

FIG. 3 is a sectional view of the pattern of FIG. 1 taken on line 3-3 of FIG. 1;

FIG. 4 is a front view of the pattern of FIG. 1 with a lower slot;

FIG. 5 is a top view of the pattern for an incisor tooth;

FIG. 6 is a front view of the pattern of FIG. 5 as viewed from line 6-6 of FIG. 5;

FIG. 7 is a section taken on line 7-7 of FIG. 5;

FIG. 8 is an enlarged perspective view of a pattern mounted on a tooth stub form with coping and wires.

The dental pattern is prefabricated and thin walled. A pattern is provided for at least each different tooth in the mouth. Each molar pattern 10, one being illustrated in FIGS. 1-4, has outer surfaces conforming with the lingual surfaces 11, mesial and distal surfaces 12, and occlusal surface 13 of the respective molar which is to be replaced or capped, that is the molar pattern has its exterior surfaces conforming with that of its respective natural tooth. The pattern for each incisor tooth, one being illustrated in FIGS. 5-7, has a lingual surface 17, and distal and mesial surfaces 18 conforming to a natural tooth. The bottom or gingival portion of each pattern is semicircular or generally semicircular or oval and can be shaped to conform with the tooth stub to receive a restoration or with the shape of a coping which has been prepared to fit over a tooth stub. The pattern has an incisal or front edge 19 and a gingival edge 20. The portion of the pattern adjacent to the gingival edge provides a gingival portion.

The pattern has slot means, a single central slot being shown, extending from the incisal or front edge. For a molar

pattern, the slot 21 preferably extends roughly the full depth of the occlusal surface 13 and may extend downwardly into the lingual wall. In any event it is about one-half of the combined dimension of the occlusal and lingual walls. For an incisor pattern 16 the slot 22 extends roughly about one-half of the height of the pattern. There is considerable latitude in the length of the slot although the slot should not be so long that some of the bottom of the pattern can not be trimmed off without unduly weakening the connection between the halves of the pattern. Such trimming may be required such as for a short tooth or a short restoration. The slot is relatively substantial width so that the width of the pattern can be narrowed sufficiently by pressing the edges together to partially or even fully close the slot the required amount to fit the prefabricated pattern into the space between the sides of the abutting or adjacent teeth. The slot should be wide enough to enable narrowing the pattern for any space between abutting teeth. The pattern can be spread to widen the slot to adjust the pattern to conform it with the space between the adjacent teeth to properly close the space therebetween. The slot desirably is wedge-shaped or tapers. Preferably the bottom of the slot is widened on each side, shown as a round hole, to increase the ability of the pattern to be modified as described for the full length of the slot.

A pattern made of plastic should have a low melting point or vaporization temperature so that it will burn out of the tooth or bridge mold without residue when the mold is heated for subsequently casting of the frame of the restoration. When the pattern is made of gold it remains in the mold after the wax is burned out and forms a part of or the surface of the lingual portion of the finished frame and restoration. The gold-used as a pattern material should have a composition as will be defined below.

If desired the bottom portion of the pattern may also have slot means, one slot 23, FIG. 4, being shown, so that the gingival portion may be more extensively or more easily modified to fit a coping or the stub of a tooth to be capped than is afforded by a pattern without this additional slot.

A pattern made of plastic having the characteristics described above is also one which can be burned out of the mold cavity in the usual temperature range to which the mold is subjected in order to melt or vaporize and thereby eliminate the pattern and wax in this manner from the mold cavity. There are many plastics having this characteristic, examples of which are polyvinyl acetate, polyethylene and copolymers thereof. For a plastic pattern, greater latitude as to thickness of the pattern wall is permissible and a thickness of approximately 13 to 16 thousandths of an inch is satisfactory so long as it retains its ability to be closed or spread to fit the space between adjacent teeth and also for occlusion and contact for a posterior tooth. The plastic pattern should have the characteristic of (1) softness or pliability so that it can be adapted or modified by the technician and (2) retentivity so that it retains its modified shape. Shore A hardness of about 70 will have the necessary characteristics described above.

The pattern may also be made of gold which again should have the characteristic (1) softness or pliability to be shaped, that is narrowed, or widened, occlusal and contact or otherwise modified and (2) of retaining its modified shape or form. For a gold pattern a thickness of about six- to eight-thousandths of an inch is desirable. The softness of a pure gold has the proper characteristic as to softness. Since gold is expensive a minimum thickness is economical. The interior of the gold pattern is backed by wax such as 26 gage. The resultant combined thickness of .006 of the prefabricated pattern and the 26 gage wax replaced by gold in the casting process, provides a frame which is amply strong for dental purposes. In addition, the gold pattern is not burned out of the mold but is retained therein to form a part of the finished lingual portion of the frame of the restoration. It is for this reason that when the pattern material is gold, it should be of a composition which does not oxidize. The reason for this is that if a gold which oxidizes is used, the oxidation forms a thin inner

coating into which additional gold will not adhere when the frame or crown is cast. Preferably the gold of the pattern and the cast gold has the same color. Both the plastic and gold material of the pattern will accommodate the occlusion of the posteriors by pressure or biting.

Preferably the pattern has a plurality of wire holes 27 in the upper portion thereof so that the dental technician may project wires therethrough, such as of metal, which do not burn out or of plastic which do burn out. The metal wires remain within the mold to form a part of the frame and a more positive anchorage means for the facing or veneer material subsequently applied to the buccal or labial frame to complete the restoration. When plastic wire is used the cast gold fills the space formed by the burned out plastic wires to provide the retention for the veneer.

Frequently, a patient is not concerned with having a molar tooth restored with a porcelain or plastic facing. In this event, the pattern is used as described but the pattern is waxed fully and the buccal portion is carved to its desired anatomy, invested, burned out and cast and in this manner a full cast crown is obtained. Similarly, the gold pattern may be used, waxed and carved to the shape of a complete molar or molars to form a full crown. This crown is then invested, the wax burned out leaving the gold pattern within the mold cavity. The crown is then cast and the pattern or patterns become a part of the finished restoration.

Two or more patterns may be assembled together to form a bridge of a plurality of teeth. Such bridges are formed using the usual technique known to the dental profession.

The invention is also directed to a method of making a dental frame or crown using the prefabricated pattern or patterns as described. The invention also includes a method of making a dental mold by investing the prepared frame, and burning out the frame including the plastic pattern. In practicing the method, the pattern described is used and its internal cavity is prepared with wax and shaped to the desired frame after which the slot means is filled with wax to form a completed frame. The waxing may include waxing at the gingival edge to lengthen the frame. A simple way to form an anchorage for the veneer is to project wires 29 through the holes 27 so that this step is preferably included. The frame is invested in known manner including the plastic pattern if used which is burned out to provide a mold cavity for the frame. If the prefabricated pattern is of gold it is not burned out but remains in the mold cavity after which the frame mold cavity is filled with casting gold in known manner to provide a cast frame or a complete crown or restoration. The gold pattern becomes a part of the completed frame or restoration.

In making a frame construction in most cases, a coping 31

of thin plastic is shaped to the stub S of the tooth to be capped, an impression of which is provided by the dentist. The gingival portion of the pattern is then fitted to this coping so that the coping becomes a part of the frame construction. The wires 29 about the coping. If metal wires are used, these wires remain to form the retention means for the cast frame. If the wires are plastic, the plastic wire burns out leaving holes in the investing mold which are filled with casting metal when the frame is cast to form the retention means for the cast frame. The coping burns out when the mold is heated.

This invention is presented to fill a need for improvements in a Prefabricated Dental Pattern having Adjusting Slot Means. It is understood that various modifications in structure, as well as changes in mode of operation, assembly, and manner of use, may and often do occur to those skilled in the art, especially after benefiting from the teachings of an invention. This disclosure illustrates the preferred means of embodying the invention in useful form.

We claim:

1. A prefabricated dental form comprising a thin pattern having an exterior surface conforming to the configuration of the lingual portion of a tooth including the mesial and distal surfaces for an incisor and the mesial, distal and occlusal surfaces for a molar, slot means including at least one slot extending from the incisal edge to roughly one-half of the dimension of the pattern, the slot having a substantial width to permit narrowing or widening of the pattern to accommodate the pattern for tooth spacing, the material of the pattern being relatively soft so that it can be modified as to width and form and being of sufficient retentiveness so that the pattern will remain in its modified form, and the pattern being relatively thin having a thickness roughly of about six-thousandths of an inch.

2. A prefabricated dental form as in claim 1 in which the slot means is a single centrally located slot.

3. A prefabricated dental pattern as in claim 1 in which there is a short widening of the slot at the bottom of the slot and on each side thereof.

4. A prefabricated dental pattern as in claim 1 and including a plurality of holes through the pattern of a diameter to receive a wire and located in the region on each side of the slot so that anchorage is provided for a facing.

5. A prefabricated dental pattern as in claim 1 in which the material of the pattern is a plastic having about 70 Shore A hardness and having a burnout temperature such that it will be eliminated when the mold is heated.

6. A prefabricated dental pattern as in claim 1 in which the material of the pattern is dental gold and having a nonoxidizing characteristic.

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[54] **SUSPENSION FOR MAKING MOLDS IN DISPOSABLE PATTERN CASTING**

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[21] Appl. No.: **668,185**

[22] Filed: **Mar. 18, 1976**

[51] Int. Cl.² **B28B 7/34**

[52] U.S. Cl. **106/38.35; 106/38.2;**
106/38.3; 106/287.16

[58] Field of Search **106/38.3, 38.35, 38.2,**
106/38.22, 287 SE; 164/25

[56] **References Cited**

U.S. PATENT DOCUMENTS

3,428,465	2/1969	McLeod	106/38.35
3,432,312	3/1969	Feagin et al.	106/38.35
3,725,090	4/1973	Lyass et al.	106/38.35

3,870,529 3/1975 Okumoto et al. 106/38.35

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[57] **ABSTRACT**

A suspension for making molds, containing a binder which comprises alkyl silicate, water and hydrochloric acid, a refractory filler which has a grain size mainly of not more than 50 mu, and a surfactant featuring a wetting and plasticizing effect. Moreover, the composition of said suspension incorporates a phosphate.

The weight percentage of said components in the suspension is as follows:

alkyl silicate	— 2.5 — 9.0
water	— 16.5 — 23.0
hydrochloric acid	— 0.05 — 0.25
phosphate	— 0.2 — 1.0
surfactant	— 0.02 — 0.10
refractory filler	— the balance.

6 Claims, No Drawings

SUSPENSION FOR MAKING MOLDS IN DISPOSABLE PATTERN CASTING

The present invention relates to foundry practice and more particularly to suspensions for making molds in disposable pattern casting.

The present invention may prove to be most advantageous in the mass or lot production of machine and instrument parts.

Actually foundry molds are made by dipping patterns in a suspension which is followed by powdering them with a refractory and hardening of a produced layer. The number of such layers is three and more, depending on the mass and overall dimensions of an assembly of patterns.

As a rule, the composition of a liquid phase of said suspension includes expensive organo-silicon compounds — alkyl silicates: methyl-, ethyl-, butyl and isopropyl silicates, ethyl silicates being employed preferably.

Further improvement of said suspensions is aimed, firstly, at providing a high bench life, i.e. a capacity to retain stable functional properties over a long period of time, and, secondly, at enhancing the specific strength of the molds obtained by hardening said suspension, which allows diminishing the number of layers building up a mold or producing heavier castings or, finally, assuring a saving in alkyl silicates.

The term "specific strength" is used herein to denote an absolute static bending strength of a mold specimen reduced to 1% of fictitious silica content in alkyl silicates.

Alkyl silicate binder-based suspensions usually contain a considerable quantity of organic solvents. Accordingly, since these solvents are all toxic as well as fire and explosive hazards, it is very important that these dangers be minimized.

High organic solvent content in the suspensions not only adversely affects working conditions and add to fire hazards but adversely affects functional properties of the composition. Thus, the composition of a suspension for making foundry molds (see, e.g., U.S. Pat. No. 3,576,652, Cl.106-38.35) incorporates acetone. However, high acetone volatility leads to an intense increase in suspension viscosity and prevents obtaining an adequate refractory powdering owing to early drying of the suspension layer. Non-uniform powdering layers give rise to cracks in molds.

To overcome said disadvantage use is made of special acetone vaporization depressors or a single inexpensive solvent is replaced by a combination of less volatile organic diluents, thus complicating the production process and necessitating the use of such toxic material as methyl alcohol, benzol, methyl isobutyl ketone and petrol. The introduction of the vaporization depressors, as well as the application of said combination solvents do not obviate the use of a large number of fire- and explosion-hazardous substances.

To provide adequate mold strength in the disposable pattern process use is made of suspensions with a high alkyl silicate content. Thus, known already in the prior-art is a suspension (see, e.g., British Pat. No. 1,287,432, Cl.C1A), comprising a binder of ethyl polysilicate, isopropyl alcohol, water and hydrochloric acid, and a refractory filler, the weight percentage of the components being as follows:

ethyl polysilicate — 19.5

isopropyl alcohol — 11.1

water — 1.65

hydrochloric acid — 0.04

filler — the balance.

Also known is a suspension for making molds in disposable pattern casting (see, e.g., French Pat. No. 2,070,366) whose composition incorporates an ethyl silicate-based binder containing over 25% of fictitious silica, i.e. over 18.5% by weight of ethyl silicate as calculated for the suspension composition.

However, said suspensions are expensive owing to a high ethyl silicate content.

To make a mold less costly and to decrease ethyl silicate requirements use is made of combination binders. Known already in the prior-art is an alkyl silicate binder employed in combination with epoxy resins or benzene polystyrene solutions (see, e.g., U.S. Pat. No. 3,576,652, Cl.106-28.35). Said materials add considerably to gas evolution properties of the mold and, hence, to a probability of blow holes in castings. Moreover, the use of polystyrene and epoxy resins in the disposable pattern process, comprising firing at a temperature of 800°–1000° C., results in atmospheric pollution with carcinogenic products.

Also known are two compositions of suspensions for making foundry molds (see, e.g., British Pat. No. 1,207,101, Cl.B5A). One of said compositions employs an aqueous-alcohol solution of ethyl silicate containing 50% of ethyl silicate, whereas the other one uses aqueous solutions of sodium and potassium silicate as a binder, a feature which naturally reduces the cost of the molds. Said suspensions are applied in layers on a pattern, i.e. a combination coating is obtained. However, this combination may cause mold cracking at high temperatures owing to different thermophysical properties of the layers. It may also deteriorate the accuracy of the castings being produced in said molds due to high plastic deformations of the layers obtained from the suspension using aqueous solutions of sodium and potassium silicates as a binder, at the temperatures required for firing the mold and pouring metal therein.

Attempts at producing less costly suspensions for making molds in disposable pattern casting, as well as at minimizing fire- and explosion hazards in the suspension- and mold-making process resulted in providing a suspension (see, e.g., Inventor's Certificate of the USSR No. 162638) containing ethyl silicate, water, hydrochloric and sulfuric acids employed as a binder, and a refractory filler, the weight percentage of the components being as follows:

ethyl silicate — 12–15

water — 13.5–16.5

hydrochloric acid — 0.2–0.3

sulfuric acid — 0.15–0.20

pulverized quartz - filler — the balance.

However, the composition of said suspension incorporates large amounts of ethyl silicate and the molds feature low strength. The specific bending strength ranges from 5.9 to 7.3 kgf/cm².

Also known is another suspension for making molds in disposable pattern casting (see, e.g., Inventor's Certificate of the USSR No. 426743), comprising ethyl silicate, water, hydrochloric and sulfuric acids employed as a binder, a refractory filler and a surfactant that is sparingly adsorbed on the surface of filler grains, the weight percentage of the components being:

ethyl silicate — 5–9

water — 14–18

hydrochloric acid — 0.25–0.35

sulfuric acid — 0.25–0.35

surfactant sparingly adsorbed on filler grain surface — 0.02–0.10

refractory filler — 75–77.

The surfactant sparingly adsorbed on the surface of the filler grains features a wetting and plasticizing power by virtue of which the molds exhibit a higher bending strength of about 40 kgf/cm², their specific strength being 5.65 kgf/cm². In terms of its strength characteristics said suspension is superior to those containing water as a diluent, yet it is inferior to traditional compositions, comprising organic solvents. The bench life of said composition is not great; it amounts to about 48 hrs. Said small bench life of the suspension restricts the range of surfactants which may have been employed therein. A number of surfactants in wide use and not costly, such as alkyl sulfates, alkyl-aryl sulfonates, on being introduced into the composition cause rapid coagulation thereof. A limited bench life of the suspension and low strength of the molds produced thereof are associated with a relatively high concentration of strong hydrolysis reaction and alkyl silicate polycondensation catalysts, which are present in the suspension simultaneously - hydrochloric and sulfuric acids. The high rate of said reactions determined by a high content of said acids - catalysts causes suspension aging and the formation of coarse-disperse binding gel with inherent stresses.

The main object of the present invention is the provision of a suspension for making foundry molds which would not contain organic solvents and would retain its functional properties over a long period of time, i.e. would feature a long bench life, assuring better physicomachanical properties of the molds both in a cold and hot state at a lower consumption of ethyl silicate, particularly ensuring a higher specific strength of the molds.

In accordance with the aforementioned and other objects the essence of the present invention consists of a suspension for making molds for disposable pattern casting, containing alkyl silicate, water and hydrochloric acid as a binder, a refractory filler with a particle size mainly not over 50 μ , and a surfactant featuring a wetting and plasticizing effect, according to the invention, comprises phosphates, the weight percentage of the components being as follows:

alkyl silicate — 2.5–9.0

water — 16.5–23.0

hydrochloric acid — 0.05–0.25

phosphate — 0.2–1.0

surfactant featuring wetting and plasticizing effect — 0.02–0.1

refractory filler — the balance.

The hydrochloric acid, phosphate and surfactant contents are given as calculated for an active component.

Alkyl silicates are orthosilicic acid esters. Methyl-, ethyl-, isopropyl- or butyl silicates can be also employed, ethyl silicate with a 28 to 52% fictitious silica content being preferable.

As for the wetting and plasticizing surfactants, use may be made of a wide range of materials: alkyl sulfates, alkyl-aryl sulfonates salts of sulfosuccinic acid esters, salts of condensation products of fatty acid chlorides with methyl taurine (methaupon), oxy-ethylated alkyl phenols and aliphatic series alcohols, glycidol-deriva-

tives of alkyl phenol, and sulfonated oxy-ethylated compounds.

Pulverized materials, such as crystalline and fused quartz, chamotte (refractories which have the general formula $n\text{Al}_2\text{O}_3 \cdot m\text{SiO}_2$), alundum, zirconium silicate, zirconium dioxide can be used as a refractory fine-disperse filler. Fine-disperse refractories are also adaptable with a total up to 2.0% impurity content, including iron entrained while grinding the refractories by using steel or iron grinding means. The above-specified component compositions correspond to a refractory filler having a density of 2.7 g/cm³, e.g., quartz. When using another filler, such as, zirconium dioxide with a 5.73 g/cm³ density, the component ratio must be recalculated accordingly.

It is expedient that the suspension contain such phosphates as: orthophosphoric acid or diphosphates of the following elements - copper, magnesium, calcium, zinc, aluminium, titanium, chromium, manganese, iron, nickel, cobalt, zirconium, barium.

As to other phosphates to be incorporated into the suspension composition, use can be also made of compositions containing two and more diphosphates, e.g., aluminochromophosphate (phosphates of aluminum and chromium).

The phosphates can be either prepared separately or introduced into the suspension with materials forming said phosphates, such as, metals, their oxides or hydroxides together with orthophosphoric acid. In this case diphosphates are produced at the same time as the suspension proper is being prepared.

The suspension of the above-specified composition exhibits a 2–3-fold increase in its bench life and a 1.5–2-fold increase in its specific strength, as compared with the similar prior-art compositions without organic solvents. In terms of said parameters it is not also inferior to traditional compositions, comprising organic solvents and in certain functional properties it is even superior: it features a high sedimental stability, its density rises slowly (1–2 s per hour with continuous stirring), an ignition temperature in an open container varies from 70° C. to 90° C., the suspension building up uniform layers without inflows.

High functional properties of the proposed suspension are determined by the adopted ratio of its components, as well as by the presence of said phosphates. An extended bench life is provided because the introduction of said compounds imparts buffer properties to the suspension, i.e. its pH changes very little over a long period of time, in spite of a decreased concentration of hydrochloric acid due to its volatility or to acid consumption for reactions with the filler impurities occurring with time.

Improved physicomachanical properties depend on high adhesion of phosphates to filler grains and to reactions between the phosphates and amorphous silica of the ethyl silicate binder, said silica becoming active at the instant it is produced. The reaction products exhibit properties. The introduction of phosphates proper also adds to suspension strength.

The suspension, according to the invention, is prepared by intense stirring of all its constituents at a rate of 1000–3000 rpm which lasts 30–60 min. After that it is applied in layers to patterns, powdered with a refractory with a grain size of at least 100 μ , e.g., quartz sand. A pattern composition is removed from the hardened mold by any known method.

Suspension composition, % by weight										Suspension and mold properties									
Phosphate																			
No. of Ex.	Alkyl silicate (name and concentration)	Hydrochloric acid		Phosphoric acid	Diphosphates		Refractory filler the balance	Viscosity(s)		Bending strength		Specific bending strength (per 1% of fictitious silica)							
		Water						0 hr	48 hrs	20°	900°	20°	13	14					
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15					
1.	9TC-40; 2.0	23.5	0.125	0.75	—	—	Pulverized quartz	44	47	24.8	38.1	31.0	47.6	Inadequate strength					
2.	9TC-40; 2.5	23.0	0.15	0.75	—	—	"	38	43	31.5	43.9	31.5	44.0	Owing to stabilizing effect of phosphates a diversified range of surfactants can be used					
3.	9TC-52; 2.8	22.7	0.20	0.75	—	—	"	40	45	36.8	19.2	30.0							
4.	9TC-40; 4.8	20.7	0.125	0.75	—	—	alkyl-aryl sulfonate; 0.08	40	49	57.9	—	—							
5.	"	20.7	0.125	0.75	—	—	alkyl sulfate; 0.08	45	56	54.2	—	—							
6.	"	20.7	0.125	0.75	—	—	Na-salt of sulfosuccinic acid ester; 0.10	39	47	52.0	—	—							
7.	"	20.7	0.125	0.75	—	—	Sulfonated oxy-ethylated aliphatic series alcohol; 0.08	42	49	57.6	—	—							
8.	9TC-40; 9.0	16.5	0.25	0.75	—	—	Methaupon; 0.1	42	58	75.4	116.6	21.0	32.3		In examples No. 11 and No. 12 the denominator (column 11) gives the strength of a mold made from a suspension that has been stored for 48 hrs.				
9.	9TC-40; 9.5	16.0	0.25	0.75	—	—	"	48	79	76.2	120.5	20.0	31.5						
10.	9TC-32; 9.0	16.5	0.20	0.75	—	—	"	50	67	60.8	—	29.4							
11.	9TC-40; 7.5	18.0	0.25	0.20	—	—	Oxy-ethylated alkyl phenols; 0.05	34	42	64.4	114.8	21.5	38.3						
12.	"	18.0	0.25	0.10	—	—	"	35	64	58.7	97.3	20.5	32	The bench life is appreciably lower than in Example 11.					
13.	9TC-40; 6.7	18.8	0.06	1.0	—	—	"	40	47	69.1	134	25.8	50.0						
14.	"	18.8	0.06	1.15	—	—	"	37	42	74.8	153	27.8	57.0	Reduced gas permeability and yielding of the mold owing to high phosphate content.					
15.	9TC-40; 4.8	20.7	0.125	0.75	—	—	alundum	—	—	59.3	114.3	30.8	59.5						
16.	"	19.2	0.125	0.75	—	—	chamotte	—	—	51.0	108.2	26.8	56.5						
17.	9TC-40; 8.0	17.5	0.15	—	—	—	pulverized quartz	40	49	57.6	93.6	18.0	29.3						
18.	"	17.5	0.15	—	—	—	"	38	41	60.2	114.8	18.8	35.9						
19.	"	17.5	0.15	—	—	—	"	44	58	56.1	100.8	17.5	31.5						
20.	"	17.5	0.15	—	—	—	"	37	41	58.4	108.9	18.3	34.0						
21.	"	17.5	0.15	—	—	—	"	35	37	61.4	103.2	19.5	32.3						
22.	"	17.5	0.15	—	—	—	"	39	42	55.4	94.4	17.4	29.5						
23.	"	17.5	0.15	—	—	—	"	36	41	64.8	115.8	20.3	36.0						
24.	"	17.5	0.15	—	—	—	"	35	39	50.1	97.6	15.8	30.5						
25.	"	17.5	0.15	—	—	—	"	37	41	57.2	96.0	18.0	30.0						
26.	"	17.5	0.15	—	—	—	"	36	42	67.2	97.6	21.0	30.5						
27.	"	17.5	0.15	—	—	—	"	41	49	56.8	88.0	17.8	27.5						
28.	"	17.5	0.15	0-6	—	—	"	40	48	68.0	99.2	21.3	31.0	Phosphate is prepared simultaneously with the suspension					

Owing to stabilizing effect of phosphates a diversified range of surfactants can be used

In examples No. 11 and No. 12 the denominator (column 11) gives the strength of a mold made from a suspension that has been stored for 48 hrs.

The bench life is appreciably lower than in Example 11.

Reduced gas permeability and yielding of the mold owing to high phosphate content.

Phosphate is prepared simultaneously with the suspension

EXAMPLE

14.9 l of water, 355 ml of hydrochloric acid with a 1.15 density, 415 ml of aluminophosphate with a ratio of $P_2O_5:(Al_2O_3 + Cr_2O_3) = 2.3$; 3.2 l of ethyl silicate 40 having a 1.05 density, 100 g of disodium salts of sulfosuccinic acid which is a surfactant featuring a wetting and plasticizing effect; 44 kg of pulverized crystalline quartz with a minimum particle size of 50 μ are loaded into a mixer tank, a stirrer speed being 2800 rpm. The composition is being stirred for 60 min.

Suspension viscosity is determined by the time required for the suspension to flow through a 100 ml viscosimeter funnel with a calibrated opening, 4 mm in diameter. The time of efflux of 100 ml of the suspension in seconds is the conventional or just the viscosity of said suspension.

The viscosity measured directly after 60-min stirring was 45 s. Specimens were immersed in said suspension which was applied in three layers, each layer being powdered with quartz sand with 0.2 mm grains and subjected to drying for 3 hrs.

The static bending strength of 3-layer specimens under normal conditions (20° C.) was 57 kgf/cm² and 107 kgf/cm² at 900° C. The suspension was stored at 17° C.

The strength of the specimens produced by using the same suspension upon storing for 48 hrs amounted accordingly to 52 and 103.5 kgf/cm². Within that time period the suspension viscosity increased to 50 s, i.e. it remained within technological limits.

The suspensions employed in other examples were prepared in a similar way. The composition of these suspensions and their parameters are given in a Table.

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-continued

continued																		
Suspension composition, % by weight										Suspension and mold properties								
No. of Ex.	Alkyl silicate (name and concentration)	Phosphate							Refractory filler the balance	Viscosity(s)		Bending strength kgf/cm ²			Specific bending strength (per 1% of fictitious silica)			Notes
		Water	Hydrochloric acid	Phosphoric acid	Diphosphates					0	48 hrs	20°	900°	20°	900°			
29.	"	17.5	0.15	0-6	barium phosphate; 0.8 chromoalumophosphate; 0.8				"	44	58	56.4	88.0	17.5	27.5	15		
30.	"	17.5	0.15	0-6	iron and titanium phosphates 1:1; 0.8 copper and zirconium phosphates 1:1; 0.8				"	36	49	63.2	97.6	19.8	30.5			
31.	"	17.5	0.15	—					"	37	42	57.6	100.6	18.0	25.5			
32.	"	17.5	0.15	—					"	37	43	59.8						

What we claim is:

1. In a suspension suitable for making molds useful in disposable pattern casting, consisting essentially of from 2.5 to 9.0 percent by weight of a C₂-C₄ alkyl silicate, from 16.5 to 23.0 percent by weight of water, from 0.05 to 0.25 percent by weight of hydrochloric acid, from 0.02 to 0.10 percent by weight of a surfactant selected from the group consisting of alkyl sulfates, alkyl-aryl sulfonates, salts of sulfosuccinic acid esters, sodium salts of condensation products of fatty acid chlorides with methyl taurine, oxy-ethylated alkyl phenols and aliphatic alcohols, glycidol derivatives of alkyl phenol and sulfonated oxy-ethylated compounds, the balance being refractory filler having a grain size of not more than 50 mu; the improvement comprising from 0.2 to 1.0 percent by weight of a phosphate selected from the group consisting of diphosphates of copper, magnesium, calcium, zinc, aluminum, titanium, chromium, manganese, iron, nickel, cobalt, zirconium and barium, aluminochromophosphate and their mixtures.

2. A suspension of claim 1, comprising the following components, the weight percentage of said components being:

- ethyl silicate — 8.0
- water — 17.5
- hydrochloric acid — 0.15
- copper diphosphate — 0.9
- alkyl-aryl sulfonate — 0.08
- pulverized quartz — the balance.

3. A suspension of claim 1, comprising the following components the weight percentage of said components being:

- ethyl silicate — 8.0
- water — 17.5
- hydrochloric acid — 0.15
- iron diphosphate — 0.6
- alkyl-aryl sulfonate — 0.08
- pulverized quartz — the balance.

4. A suspension of claim 1, comprising the following components, the weight percentage of said components being:

- ethyl silicate — 8.0
- water — 17.5
- hydrochloric acid — 0.15
- diphosphate of chromium and aluminium — 0.8
- surfactant - alkyl-aryl sulfonate — 0.08
- refractory filler - pulverized quartz — the balance.

5. A suspension of claim 1, comprising the following components:

- ethyl silicate — 3.2 l
- water — 14.9 l
- hydrochloric acid — 355 ml
- aluminochromophosphate — 415 ml
- disodium salts of sulfosuccinic acid — 100 gms
- pulverized crystalline quartz — 44 gms.

6. A suspension of claim 1, wherein the alkyl silicate is ethyl silicate.

* * * * *



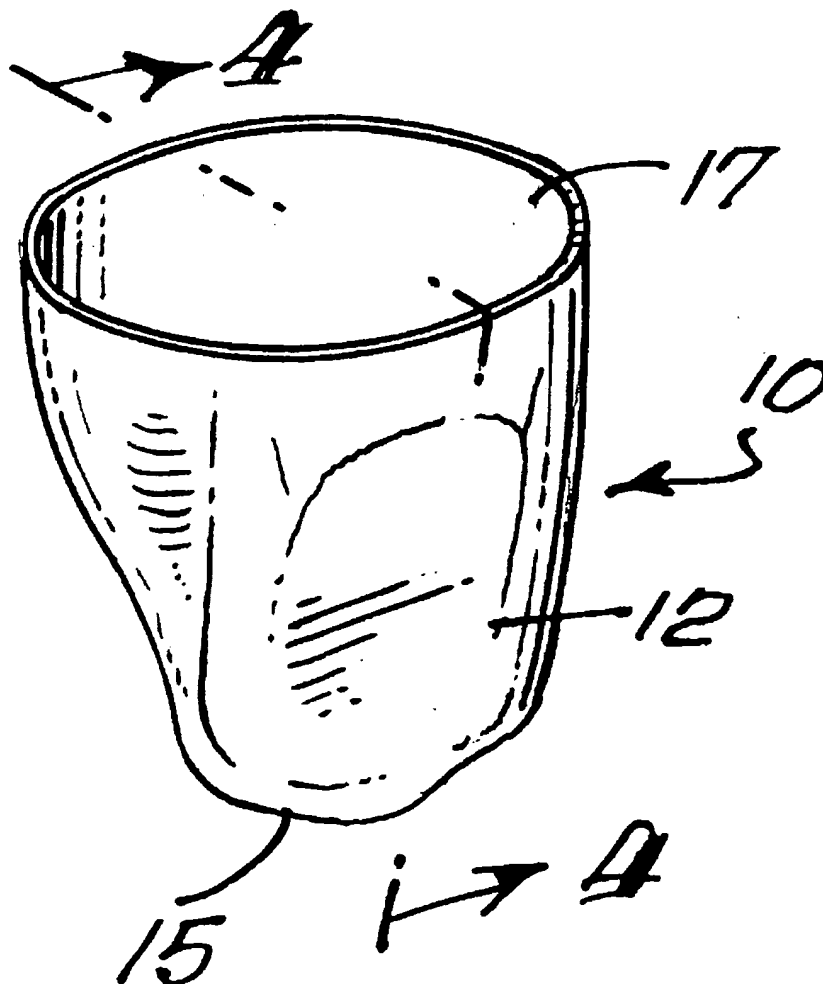
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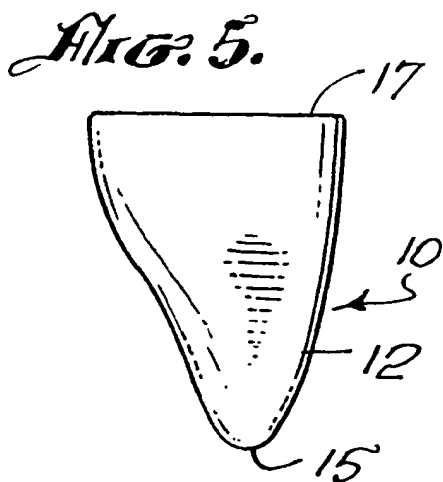
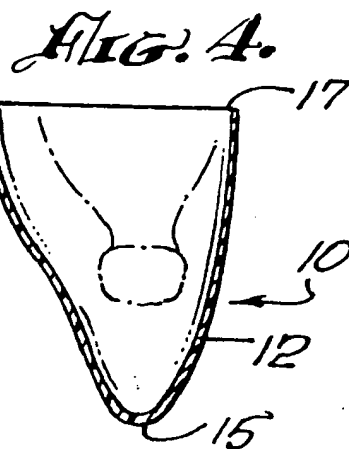
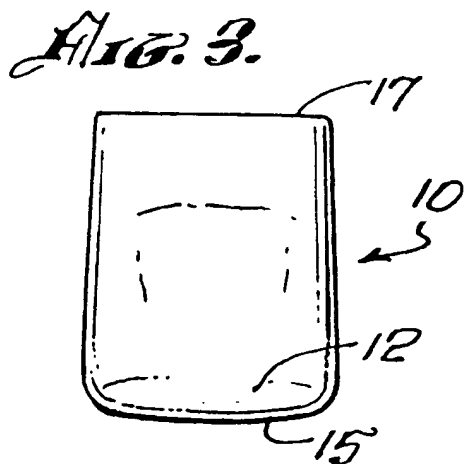
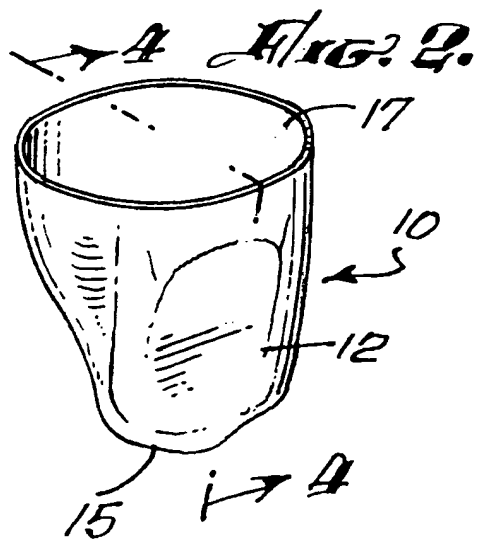
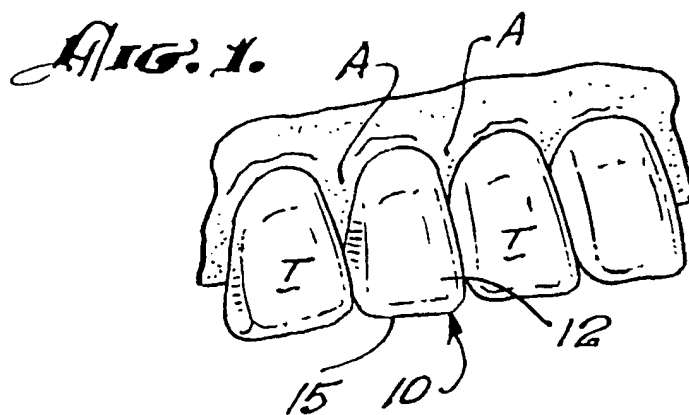
United States Patent [19]**Wilson**[11] **Patent Number:** **5,487,663**[45] **Date of Patent:** **Jan. 30, 1996**[54] **ORAL APPLIANCES AND METHOD**[76] **Inventor:** **George M. Wilson**, 1536 Goddard Dr.,
Visalia, Calif. 932774,129,946 12/1978 Kennedy 433/37
4,678,435 7/1987 Long 433/218
4,778,386 10/1988 Spiry 433/223[21] **Appl. No.:** **357,074**[22] **Filed:** **Dec. 15, 1994***Primary Examiner*—Cary E. O'Connor
Attorney, Agent, or Firm—Dennis B. Haase**Related U.S. Application Data**

[63] Continuation of Ser. No. 106,580, Aug. 16, 1993, abandoned.

[51] **Int. Cl.⁶** **A61C 5/08**[52] **U.S. Cl.** **433/218; 433/223**[58] **Field of Search** 433/40, 202.1,
433/212.1, 218, 223, 219, 183[56] **References Cited****U.S. PATENT DOCUMENTS**3,585,723 6/1971 Simor 433/219
4,015,332 4/1977 Manne 433/219[57] **ABSTRACT**

The present invention relates to the method and apparatus for forming a dental crown on a prepared tooth. A dental appliance is provided in which a resinous jacket is provided, and is capable of serving both as a crown and a crown form, the jacket having relatively thinner, straight, side walls. When used as a crown, the inner surface of the jacket is coated with a bonding agent, and the jacket is then filled with a composite restorative material, after which, the jacket is fitted over the prepared tooth to be restored, to give a resultant highly effective crown, either by leaving the jacket in place, or by removing it, in which case the composite restorative material serves as the crown, standing alone.

12 Claims, 1 Drawing Sheet



ORAL APPLIANCES AND METHOD

This is a continuation of application Ser. No. 08/106,580, filed Aug. 16, 1993, now abandoned.

The present invention relates, in a general sense, to an aesthetically and functionally improved, preformed resin, dental crown, and, more particularly, to a preformed resin dental crown which may also serve as a dental crown form, together with a novel method of preparing the same.

BACKGROUND OF THE INVENTION

Background of the Invention

The dental profession, since the advent of tooth repair, has sought out materials and devices which were pliable, yet strong enough to withstand the several thousand pounds per square inch bite pressures which are capable of being experienced.

Depending on the degree of permanency needed, a variety of materials have been used, ranging from gold, at one end of the spectrum, to a wide range of plastics at the other end. Temporary crowns may even be aluminum, or aluminum alloys of various compositions.

In most instances, the process of fitting a patient with a custom crown begins with the preparation of the tooth, after which an impression is made, from which a crown is fashioned. Then the patient returns for the cementation of the crown, a second visit. In working with children, a one visit procedure is now possible by using a preformed crown, and that is an obvious great advantage, in that it engenders greater cooperation from an ever reticent, and often downright frightened child. The parent is delighted to have to pay for only one visit.

A preformed resin crown, as an aesthetic alternative to stainless steel crowns, have been used with varying degrees of success for some years. Failures have mainly been due from over preparation of teeth to compensate for the bulkiness, indigenous to previous plastic crowns. Other failures have been attributed to such crowns literally falling off due to the lack of satisfactory luting agent, or splitting due to internal stress caused from deformation.

Crown forms, used to fashion the crown itself, resemble a crown, but are typically very thin (0.006 inches) in wall thickness, and are intended to be discarded after use. To date, there has been little, if any, effort to amalgamate the technology of crowns and crown forms to achieve a dual function appliance.

Overview of the Prior Art

Heavy, typically inert metals, have been the standard of the industry from the time that the process of capping, rather than simply removing, damaged teeth became an acceptable and safe practice. Although metals such as gold are malleable and can withstand great bite pressures, they are bulky, and difficult to work with in the sense that with limited room between teeth in the usual mouth, they are sometimes difficult to fit. Once fitted, of course, the room to work on adjacent teeth is severely restricted, making repair of such teeth a genuine chore.

Typically, prior art preformed resin crowns, especially for children, have had contoured interproximal walls that form a constricted or narrow margin. This is due mainly to the process by which they are molded, which tends to allow greater thickness of the plastic material used to form the interproximal walls, in hopes of achieving a thinner crown

margin. While the greater interproximal thickness of plastic allows proper filling of the mold cavity "in the injection mold process", flexibility to adapt the crown over the tooth preparation is greatly compromised.

Due to the relative rigidity of prior art resin crowns more material was necessarily removed from the tooth to be fitted, and much of extra material was healthy, non carious, material which could otherwise assist in supporting the crown. It had to be removed, however, to allow an acceptable fit or adaptation.

If multiple adjacent teeth, or if a tooth adjacent to an existing crown required crowns, lack of arch space necessitated the use of smaller crowns than original teeth required, and more healthy tooth material is removed to accommodate them, all because of the thick crown walls of prior art devices.

Developments in the field of plastic materials has opened new vistas to the dental profession, and greater comfort to their patients. There appears to be a dearth of patent art, and of the art examined, the crown form of Kennedy U.S. Pat. No. 4,129,946 appears to typify current practices. The popularity of the crown form, or as Kennedy refers to it a "strip crown," was advanced significantly by the development of better composite-resin plastics. Devices, such as that of Kennedy served as the mold to hold a viscous material that would become the crown itself, and when the material was hardened, Kennedy provided a tab to facilitate the removal of the crown form, which became a throw away. Kennedy did not envision that his crown form might also serve as a crown itself, and indeed, Kennedy's device would not, in all probability, have functioned the latter capacity.

In using the crown form as a matrix only to be discarded after serving its single purpose, tends to place the success of the restoration entirely on the material that fills the form. This is one of the problems which the present invention ameliorates.

Dental composites to be useful, must have great compressive strength, but most prior art materials are brittle and their modulus of elasticity is sometimes exceeded by masticatory forces, even in children. A better restoration would result, as will later appear, by encapsulating or otherwise retaining the dental composite within a tough, protective shell, that will not fracture. It would be still better to chemically bond the crown form directly to a dental composite, thereby preventing fracture of the matrix or dislodgement of the crown.

There have been a myriad of other devices, mostly unpatented, having several features in common. For example, it is common practice to prepare a cervical margin on the damaged tooth, and by forming the crown with a negative draft above the crown margin or height of contour on the cervical margin of the tooth preparation so that it can be snapped in place or engaged over the crown margin or cervical height of contour. Use of this kind of construction, however, tends to make the resultant resin restoration more bulky than is necessary, and severely hampers the professional's ability to work on adjacent teeth.

This process of fitting a crown to a damaged tooth works well with preformed stainless steel crowns, as in the R. A. Sutar crown (3,468,028). For strength, thickness (0.006 inches), flexibility, and being able to be worked with dental pliers, the stainless steel crown has been a success, except, of course, for its aesthetics. Even children do not like to have a mouth full of stainless steel.

SUMMARY OF THE PRESENT INVENTION

With the foregoing environment established, it is a principal objective of this invention to provide an appliance

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which is capable of functioning both as a crown and a crown form.

It is another objective of the present invention to provide an appliance which is readily bonded to restorative material obviating the need of negative draft or undercut to snap on or engage the tooth preparation.

A further objective of the invention is to provide a device which is highly elastic, flexible and adaptable, yet strong enough to withstand biting and chewing, and which has essentially thin parallel interproximal walls, thus reducing mesial distal dimension, thereby allowing more room in the arch for restorative work on adjacent crowded teeth.

Yet another objective, of the present invention is to structure the crown with thin uniform wall thickness for greater adaptability, without excessive internal stresses developing in the crown, while at the same time increasing material thickness on incisal edge for greater durability in biting and chewing.

Still further, it is an objective of the present invention to provide an appliance of such flexibility as to be readily conformable to a variety of tooth shapes, thereby permitting the professional to carry a limited inventory, while at the same time accommodating a wide range of patients.

Additionally, it is yet another objective of the present invention to provide a novel method of tooth restoration.

It will become apparent that these and other objectives are accomplished by the present invention, from a study of the following detailed description of a preferred embodiment, with reference to the drawings, wherein:

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a pictorial representation of an appliance of the present invention in its anticipated environment;

FIG. 2 is a perspective of the device, unmounted;

FIG. 3 is a front elevation of an appliance constructed in accordance with the present invention;

FIG. 4 is a sectional view taken along lines 4—4 of FIG. 2; and;

FIG. 5 is a side elevation of the appliance of FIG. 3.

DESCRIPTION OF A PREFERRED EMBODIMENT

With reference now to the drawings, and initially to FIG. 2, an appliance 10 is illustrated as it appears prior to use.

The appliance 10, as shown, is primarily for use on front teeth. However, such an appliance may be readily constructed, in accordance with the present invention, for use on molars without departure from the principals enunciated here. Indeed, a simple modification of the cap, or closed end of the appliance, to conform to the surface of a molar is all that is required.

As shown, the appliance 10 is a preformed resin jacket having a generally cylindrical shape with one end, 12, being closed to define, in the embodiment depicted, an incisal surface, or edge, 15. The other end 17, which is remote from the incisal surface 15, is, of course, open.

In stark contrast to existing crown configurations, it is an important feature of the present invention that the side wall, or walls, 20 are essentially straight, as contrasted to existing art wherein the sidewalls have a distinct negative draft. When fitted, the side walls remain, for all intents and purposes, parallel. Moreover, the thickness of the side wall 20 is approximately 0.010 inches, much thinner than com-

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petitive devices, with an increased thickness in the area of the incisal edge 15 up to about 0.020 inches, to inhibit abrading and fracture due to chewing.

Accordingly, and with reference to FIG. 1, the arch area A, between adjacent teeth T, is enhanced by this combination of features, thereby permitting more facile restoration of adjacent teeth.

In practice, the appliance of the present invention provides the dental professional with several options which were hitherto unavailable in a single unit. For example, the same appliance, without modification, may serve as a crown form by partially filling the form with a dental composite restorative material, and inserting the form onto a properly prepared tooth. Excess material forced out of the form is removed and to the extent necessary, vented at or near the open end. When the restorative material is cured, either chemically, or by light, the form can be trimmed away, exposing a properly formed cap of restorative material. Roughened edges, and or high spots, can, of course, be ground or polished away, and, indeed, the composite material remaining may be shaped and sculpted to almost any desired configuration. This provides a distinct advantage in those instances where adjacent and opposite teeth are abnormally, or inconsistently shaped, or positioned.

Optionally, the appliance is left in place, serving as additional protection against biting and abrasion.

Experimentation has shown that the material from which the appliance of the present invention is made is important and, depending on the process by which the appliance is formed, two products by Eastman Chemical Company are highly recommended. If, for example, the form is to be injection molded, EKTAR® is the preferred material, and if the appliance is to be thermoformed, KODAR® is the recommended material.

In order to ensure, in keeping with the invention, proper bonding of the appliance and the restorative material, the interior of the appliance is initially coated with a bonding agent, and it has been found that family of dimethacrylates, of which Bis-GMA and urethane dimethacrylate are members, serve as excellent bonding agents. Dental composite restorative material that is made from Bis-GMA resin work very well, as does methylmethacrylate. When the appliance is to be used as a crown form, a filler material such as feldspar, silica, barium glass or zirconium glass, or other similar material, is added for strength. Also, temporary crowns for adults may be fabricated with this crown, and bonded to methylmethacrylate before luring the tooth.

When the appliance is to be used as a crown form, a bonding agent is not necessary, and indeed, would hamper the removal of the appliance upon completion of the procedure. Therefore, the appliance, when the procedure is completed, is cut away, leaving the composite restorative material to serve as the crown. The advantage to be achieved by removing the jacket, is that the remaining material can be carved, polished and sculpted as needed to fit the needs of the patient.

The preferred method of forming a crown by use of the jacket 10, is as follows:

After preparation of the affected tooth, one selects the appropriate size preformed resin crown 10, and preform such trimming as may be necessary;

Being first assured that the prepared tooth is dry, and free of foreign particulate material, the inner surfaces of the preformed resin crown is painted with a bonding agent of the family of dimethacrylates, including Bis-GMA and urethane dimethacrylate, hereinafter referred to, for simplicity's sake, simply as dimethacrylate family;

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Composite restorative material, of which Bis GMA is an excellent example, is then placed in the cavity defined by the walls of the preformed resin crown;

The crown, thus prepared, is placed over the affected tooth, and gently moved into place, after which any excess material that has extruded below the margin is removed, and the composite material is cured, using light, or chemical means, as best suits the circumstance.

If the preformed resin crown is to be used as a crown form, as distinguished from a crown itself, certain additional steps are required, namely:

Cutting and peeling away the resinous material which is the jacket 10, and

shaping and sculpting the tooth as needed.

Having thus described a preferred embodiment of the invention, what is claimed is:

1. A dual purpose dental appliance for forming a crown or serving as one, comprising:

a jacket formed of a flexible resin material, said jacket being of a generally cylindrical configuration with parallel side walls and having one end thereof closed to define a cup-like receptacle,

a coating of bonding agent on the inner walls of said cup-like receptacle, and a predetermined quantity of composite restorative material disposed in said receptacle,

said jacket being of such size as to fit over a prepared tooth, to thereby provide a crown on said tooth.

2. The appliance described in claim 1, wherein said closed end of said jacket defines an incisal edge.

3. The appliance described in claim 1, wherein said bonding agent is a member of the dimethacrylate family.

4. The appliance described in claim 3, wherein said bonding agent is Bis GMA.

5. The appliance described in claim 1, wherein the side walls have a uniform thickness between 0.01 inches and 0.02 inches thick.

6. The appliance described in claim 5, wherein the wall thickness at the incisal edge is greater than the thickness of the side walls.

7. The dental appliance as described in claim 1, wherein the side walls of said jacket in interproximal regions of said tooth are parallel.

8. A dual purpose dental appliance for forming a crown or serving as one, comprising:

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a jacket formed of a flexible resin material, said jacket being of a generally cylindrical configuration with parallel side walls and having one end thereof closed to define a cup-like receptacle,

a predetermined quantity of composite restorative material disposed in said receptacle,

said jacket being of such size as to fit over a prepared tooth, to thereby provide a crown on said tooth, wherein said jacket forms said composite restorative material into the shape of a tooth, such that, upon being cured, said composite restorative material defines a crown independently of said jacket.

9. The appliance described in claim 8, wherein the side walls have a uniform thickness between 0.01 inches and 0.02 inches thick.

10. The appliance described in claim 8, wherein the wall thickness at the incisal edge is greater than the thickness of the side walls.

11. The method of forming a crown for a tooth comprising the steps of:

preforming a flexible resin jacket having relatively straight parallel side walls;

coating the inner surfaces of said preformed flexible resin jacket with a bonding agent;

providing a measured amount of restorative material within said jacket;

fitting said jacket to a prepared tooth; and

curing said composite restorative material, whereby said restorative material is bonded to said jacket and said prepared tooth and defines a crown.

12. The method of forming a crown for a tooth comprising the steps of:

preforming a flexible resin jacket having relatively straight parallel side walls;

providing a measured amount of restorative material within said jacket;

fitting said jacket to a prepared tooth; and

curing said composite restorative material, whereby said restorative material defines a crown, wherein said preformed resin jacket is removed after said restorative material is cured.

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